E/CONF.39/A/178
26 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: A. 3. 3. 1

Federal Republic of Germany

GEOHYDROLOGICAL GROUNDWATER INVESTIGATIONS IN NORTH-AFRICAN DESERT-REGIONS BY MEANS OF COMPLEX METHODS

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Geohydrological groundwater investigations in North-African desert-regions by means of complex methods.

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Since about 1960, an international team of geologists, geochemists and physicists, all of them members of scientific institutions of their home-countries (Egypt, Germany, USA) tried to investigate North-African artesian waters.
The author reports on the research work done by the team, mainly by Dr.K.O.MÜNNICH of Heidelberg, Dr.E.T.DEGENS, at present Pasadena, USA and by himself. Contributions of Dr.SHATA, Desert Institute, Cairo are taken into consideration. The investigations sketched below are in part still under way.
In many arid and semi-arid countries we know of reserves of subsurface waters, which can hardly be explained by recent rainfall. UNESCO reviews and papers deal with the problems for years, they can not be quoted here in detail.
The question whether such occurrences belong to "live"-systems or should be regarded as "fossil" (a "water-field" like an "oil-field") is a common problem.
Our idea was to solve this problem within a restricted area in combining "classical" geology (1)(2) with new scientific tools (3) and, international cooperation with scientists of the region in question. The investigations sketched below were subsidized by scientific institutions and the Egyptian Government. They are not concerned with uncertain statements of quantities available but concentrate on methodical questions of a diagnostical type. They comprise geological studies of potential infiltration times and -areas, of reservoir-formations, chemistry of the waters in question, age- and paleo-environment-determinations by means of C^{14}, Tritium, O^{18}/O^{16}-ratios etc.
The Sahara-portion around the West-Egyptian oasis-depressions has been tackled first and will be dealt with below. The water generally is tapped within such depressions, a peculiar cuesta-feature of the central and Eastern Sahara (4)(5). The water rests and migrates within a huge and complicated reservoir consisting of the Nubian Series (Paleozoic

to Lower Cretaceous).The complex consists of an intercalation of per=meable and impermeable beds.It crops out (Fig.I.,dotted area) in the Southern portion of our region,between the Sudan-frontier in the South and the Latitude of Kharga-Oasis in the North.Further North the series disappears beneath young and different cover formations;more fine=grained intercalations appear in that direction but,in the whole,there seems to be an inter-connection of water bearing layers.The sedimentary character of the facies has been described in detail lately by E.McKee (6).After the extremely irregular sedimentation of the very widespread formation it was warped,bent and broken within the regional tectonic frames of its area.The base of the complex rests on a pre-Nubian pene=plain in the South,on folded early paleozoic belts towards the North, both seem hydrologically tight.

The water in question seems to migrate within (mainly) this Nubian Se=ries.It appears in numerous wells,formerly in many open springs.This water has been investigated in a number of wells chemically and for its absolute age.We undertook the research in spite of the possibility that,such methods might render doubtful results.The water contains comparatively little dissolved matter,generally between 100 and 500 mg/l (compare Pavlov and Burdon 1959)(7)(8).Dr.Degens,in our investi=gations offered the opinion that these waters might be altered diage=netically i.e.influenced by the long-time-contact (exchange-reactions and the like) within the storage room.He furthermore gives a number of interesting ideas which cannot be quoted in detail but which will be available in a special publication in the Geol.Rdsch.in 1963 (9). Degens regards all the waters in question as exogene or phreatic,none of juvenile origin.That means that they must be derived from rains. Those rains apparently fell according to their O^{18}/O^{16}-ratio (Ep=stein 1959)(10) rather far from any sea,inland and at some distance from their infiltration area (Degens and Epstein 1961)(11).A comparison with the (Delta)O^{18}-values of the Nile River is possible and offers some analogies.Still,a direct connection with Nile water seems very unlikely.The infiltration areas should however be looked for within the dotted region of Figure I.

As far as the migration of the subsurface waters is concerned:The pre=sent temperature of the waters (28-40°Centigrade) points towards a circulation depth barely available in the South of the occurrences. Many of the artesian waters contain free gas.In 2 wells CO_2 was found, generally Nitrogene bubbles out of the wells in considerable amounts.

This Nitrogene might be a remainder of trapped porespace-air which has been robbed of its O- and C-content.Geologically(we shall see) this assumption fits into a possible story of the water itself.We know of similar occurrences in Australian artesian wells.
The C^{14}-age of the water was determined by K.O.Münnich of Heidelberg (9).Since according to the author mentioned (3) for age determination a certain carbonate content of the water is necessary,local assays were made and samples (up to 60 liters) were taken accordingly.A Tritium-check was made,Oxygen-isotope-tests have been mentioned already.Similar investigations were made with gastropode-shells contained in freshwater deposits normally connected with the oasis-depressions in question ($C^{13}$and O^{18})(Craig 1957)(12)(Epstein and others 1953)(13).

We came to the conclusion that,if the age obtained were correct, they would indicate an infiltration of the water about 25000-40000 years ago i.e. during the later stages of the Würm- (Wisconsinian-) glaciation.Probably prior to this Pluvial (or overlapping with it), the Mediterranean sea-level was at least 150 metres lower than it is to-day owing to the general eustatic situation.Consequently,the Nile River cut its bed to a level about 150-200 below its present bed.We know that from the Aswan-Highdam-investigations.Artesian waters still enter the Nile North of Aswan.At glacial times,huge quantities of the waters in question must have leaked out of the storage complex, whose pore-space has - in exchance - been filled by air.The Nitrogene mentioned above might be derived from it.
The Nile-leakage was sealed,when the Mediterranean rose again to its present level.Pluvial waters recharged the empty storage room in the mean time.
The infiltration area of the clastic beds must have been in the South (dotted area of Figure I.),the main storage - after the comparatively thin Nubian reservoirs in the Southern portion had dried out again - should be looked for in the Northern area,which is covered by younger formations (compare Ball 1900 a.o.,Hellstrøm 1940)(14)(1).A number of details which will be discussed elsewhere (9) point towards these conclusions.
The age obtained might be correct,it can however be a "mixed" age, consisting of several "Pluvials".It can indicate the age of a single water unit also.It gives no idea about the quantities to be expected (there are doubtless enormous quantities within the region).
We undertook the investigation as an experiment to be improved at the spot and,possibly,in similar semi-arid water-occurrences elsewhere.

References (selected)

1. BALL, J., Kharga Oasis, Cairo (1900)
2. HEADNELL, H.J.L., Remarks on the prehistor. Geography etc. of Kharga Oasis. The Geogr. J. London 81 (1933)
3. BRINKMANN, R., K.O. MÜNNICH, J.C. VOGEL, C^{14}-Altersbestimmungen von Grundwasser. Naturw. 46, Gött. (1959)
4. KNETSCH, G. and M. YALLOUZE, Remarks on the origin of the Egypt. Oasis-depressions. Bull. Soc. Geogr. d'Egypte 28 (1955)
5. PFANNENSTIEL, M., Das Quartär d. Levante. II. Ak. W. u. Lit. Nr. 7, Mainz (1953)
6. McKEE, E.D., The Nubian Sandstone. Geol. Rdsch. (1963) (in press).
7. PAVLOV, M.J. and D.J. BURDON, Invest. and exploitation of groundwater for Kharga etc. Report to Gen. Des. Dev. Author. UAR, Cairo (1959)
8. PAVLOV, M.J., Groundwater of the Kharga Oasis etc. Rep. to Gen. Des. Dev. Authority. UAR, Cairo (1959)
9. DEGENS, E.T. in Knetsch, Degens, Münnich, Shata, Artesische Wässer in der östlichen Sahara. Geol. Rdsch. (1963) (in press)
10. EPSTEIN, S., The variation of the O^{18}/O^{16} ratio in nature and some geol. implications. Res. in Geochemistry, edited by P.H. Abelson. J. Wiley and Sons, New York (1959)
11. DEGENS, E.T. and S. EPSTEIN, The relationship between the O^{18}/O^{16}-ratios in coexisting rocks. Typescript, in press
12. CRAIG, H., The geochemistry of stable carbon isotopes. Geochim. et Cosmochim. Acta 4, (1953).
13. EPSTEIN, S., R. BUCHSBAUM, H.A. LOWENSTAM, H.C. UREY, Revised carbonate water isotopic temperature scale. Bull. Geol. Soc. America. 64, (1953).
14. HELLSTRØM, B., The subterraneous water in the Libyan Desert. Bull. Nr. 26, Inst. of Hydraulics, Roy. Techn. Stockholm (1940)

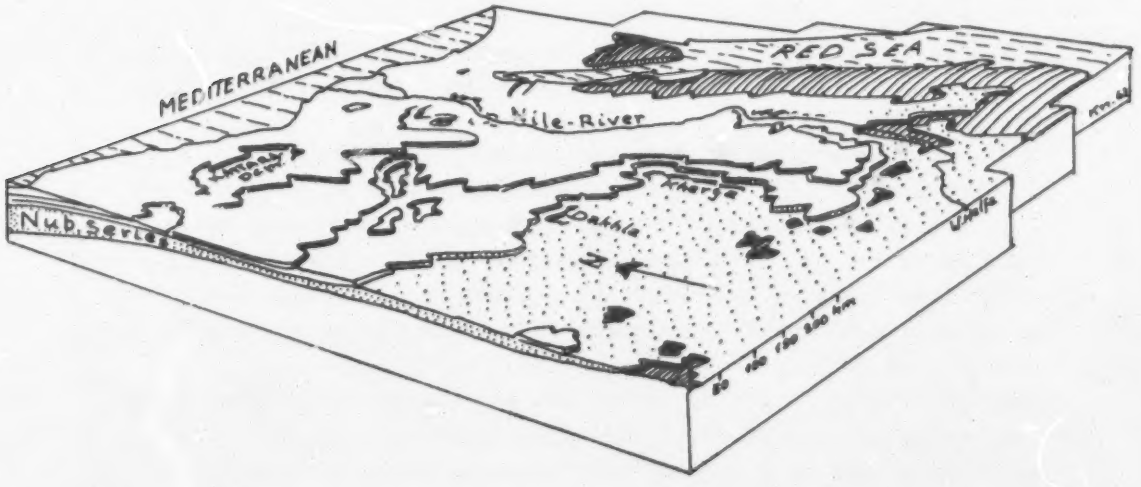

Figure I. Block-sketch of Egypt, seen from SW.
Dotted area: Nubian Series outcropping. Basement below, covering formations: U-Cretaceous and Tertiary.

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